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STREET LIGHTING SPECIFICATIONS OF THE FUTURE; SHOULD THEY BE BASED ON THE DESIGN OF THE UNIT OR THE EFFECT OF ILLUMINATION?

by Dr. S. ENGLISH, F.I.C., F.Inst.P., F.I.E.S.

(Introduction to a Discussion which took place on Tuesday, December 14th, 1943.)

When I was asked to open this discussion by putting forward one aspect of this question, I unhesitatingly accepted the invitation, since the method to be adopted for specifying street lighting is a subject which this Society should discuss, and on which it should make its opinions known before the B.S.I. Committee, which has this matter in hand, takes up its work again. Discussion of such a matter *after* the specification has been drawn up is practically useless, as at best such postponed discussion can only lead to modification of details and cannot alter the major policy of the Committee embodied in the draft specification.

In making out a case for the specification of street lighting by measurements actually made on the roadway as distinct from measurements made in the laboratory, I realise that a one-sided statement is demanded, and that everything that might be said for the other side must be ignored. I am merely putting up a case for debate, and nothing that is said should be taken down and used in evidence at a later date. To this extent, I am almost in the position of the editor of a paper or journal who emphasises that he can take no responsibility for the opinions expressed by his contributors.

In opening this case for the employment of measurements actually made on the street for the purpose of specifying street lighting, I would like to tell you a story. In the early days of the war, the British Glass Industry found itself in difficulties regarding the supply of good quality home-produced sand to replace supplies normally imported from the Continent. It was known that a possible supply existed well up a mountain side in Northern Ireland. A small committee, including a Professor fast approaching the retiring age, was appointed to investigate possibilities on the spot. Most of the committee were comparatively young men, and as the Professor had recently been ill, they, i.e., the younger ones, decided to make the ascent of the mountain gradually, but after a few turnings back and forth, following easy gradient paths, the Professor said: "Where is this quarry? Where are we going?" They pointed straight up to the mountain side. He promptly replied: "Very well, let us go there," and he strode off straight up towards their goal.

Applying that story to our present discussion, I ask: What do we want to specify? Is it street lighting, or is it lanterns? If the answer is street lighting, then let us *go to it* and specify street lighting.

It may be argued that we have tried to specify street lighting by measurements made on the road and that the specification proved unsatisfactory. It may be argued that the characteristics of good street lighting are so complex that they are unspecifiable. When I hear people talk like that, I think they should choose their words more carefully and say exactly what they mean, namely, that with the data at present available they do not see how it is possible to draw up a satisfactory specification along the lines indicated. Are we as lighting engineers going to admit that we cannot draw up a specification to meet any lighting problem based on easily made measurements of the illumination or the brightness produced? If we have to make such an admission, then we had better drop the term "engineer" and drop the qualification F.I.E.S. and be content to be regarded merely as persons "interested in the general advancement of illuminating engineering."

It may also be argued that for wartime road lighting we have found it

best to specify the performance of lanterns, and that the same procedure might with advantage be carried over to our peace-time practice. It might with equal cogency be argued that as we have managed during the war period with street lighting of the order of 0.0002 ft.c., and in many places with none at all, we might just as well carry on with these diminutive illuminations after the war. It is only necessary to state the case in this manner to show how illogical it is to argue that what has been found useful under war conditions will be found equally useful in normal times. It is probably true to say that there were two main reasons for standardising lantern performance in the case of war-time street lighting equipment:—

First, it was necessary to ensure that the illumination on the roadway did not exceed a certain very low value, and in order to be useful, it was advisable that it should be as near as possible to that prescribed limit. Hence a certain degree of uniformity or rigidity was necessary, but in peace-time lighting there is no need to keep to such narrow limits, and it would be definitely inadvisable to cramp the style of our designers by compelling them to design their lanterns to give a stereotyped performance. Such a specification would tend to put the brake on progress, and at any rate would certainly retard the development of new ideas.

The second reason for adopting laboratory tests instead of road tests for the 0.0002 ft.c. fitting was the impracticability of measuring such low values satisfactorily with portable instruments, but such a state of affairs would not continue in peace-time lighting. The very much higher values we hope to use, coupled with the very sensitive instruments that are or will be available, will make accurate readings of the illumination on the roadway a relatively easy matter. Thus it is clear that the reasons for adopting lantern performance for war-time street lighting fittings have no weight when peace-time street lighting is being considered. For the moment, however, let us suppose that we do adopt lantern characteristics as the basis of a street lighting specification. Presumably this would involve the use of polar curves of light distribution. It is notorious that, even among relatively experienced illuminating engineers, polar curves are difficult to interpret correctly, and it needs a very wide experience to enable anyone to visualise correctly from a polar curve the illumination or brightness results that will be obtained from an asymmetric lighting fitting such as is normally used for street lighting. How absurd it would be to expect the butcher, the baker, or the candlestick maker to draw any conclusions at all from such a curve, or worse still from an "onion" diagram; he would regard it as so much hocus-pocus and would ask to see what the fitting could do on the road.

Now let us look at the first two arguments a little more closely and see what, if anything, there is in them. It is true that the B.S.S. 307/1931 attempted to specify and classify street lighting by measurements of illumination on the road surface. You will all remember that the illumination at *one* particular spot—designated as the "test point"—was used to classify the street lighting, and that no fewer than eight slightly different classes were provided. It was soon found that some installations in quite low categories actually gave better street lighting, judged from the users' point of view, than other installations in higher categories, and it became more generally realised that the way in which the illumination was laid down along the roadway was much more important than the actual illumination at the test point.

In this way the importance of road surface brightness giving a light background against which objects were seen in silhouette was realised, and at the same time the danger of areas of low brightness, or "pools of darkness," was recognised. Judged by these newer standards, involving the visibility of objects on the roadway, it is true that the 1931 Specification failed, but that was not the fault of the method of measurement; it was simply that wrong or insufficient measurements were taken. The only fault that can be properly upheld

against the 1931 Specification was that it was wrongly drawn.

In immediate pre-war years the B.S.I. Committee was engaged on a revision of this Specification and appeared to be going to the other extreme by compiling a complicated specification that had few friends in the Committee and fewer still outside.

To correct this state of affairs, measurements of the road surface brightness have been suggested, but these are very difficult to take satisfactorily, and, moreover, the brightness of the road surface is not wholly under the control of the lighting engineer—the road surveyor, the motorist, the weather clerk, and "Father Time" all have a great deal to do with the reflectivity and, therefore, the brightness under artificial lighting, of road surfaces. Fortunately, it is not essential to take brightness measurements in order to ensure a satisfactory brightness pattern in ordinary conditions, for we now have considerable data on the relation between the way the light is laid down along the roadway and the brightness produced by it. We also know something of the relation between high-angle beams and the glare produced by them, so that our enthusiasm for strong beams near the horizontal, which are most effective in producing high road surface brightness, has to be kept under control. We still need much more data on these two aspects of street lighting before we can say exactly the relative importance they assume in the complicated question of visibility on roadways at night.

It is not my function in presenting this case to draw up even a skeleton specification—I would not presume to attempt such a task—but I would suggest that with the data we now have available it would be possible to draw up a specification based on illumination readings on the roadway which, when allied to suitable siting, would ensure satisfactory visibility in ordinary conditions. For this purpose it would probably be necessary to take readings at, say, five points. They could be obtained by dividing the distance between two adjacent columns into four equal steps and specifying maximum and minimum values at each of the points Nos. 2, 3, 4, and 5 as a ratio of the illumination value at point No. 1, Fig. 1.

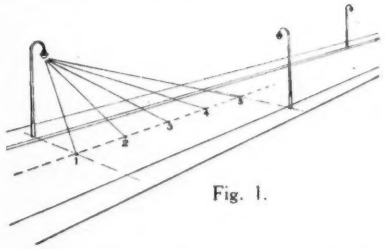

Fig. 1.

Alternatively, the points could be set out at definite distances from one column corresponding to selected angles and independent of the spacing between posts, say, 36, 77, 113, and 190 ft. which, with a 25-ft. mounting height, correspond to 55 deg., 72½ deg., 77½ deg., and 82½ deg. from the downward vertical, Fig. 2.

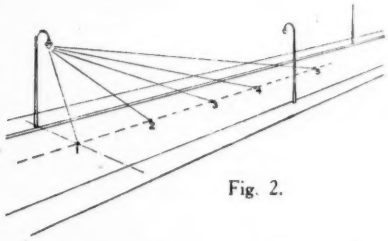

Fig. 2.

These points, if thought advisable, could be set off down the middle of the roadway and the horizontal illuminations calculated from the "normal" readings from the lamp under test, using suitable screening to eliminate stray light. To illustrate this suggestion, and merely as an illustration only—after dealing with the general major classification as set out in the M.O.T. Report concerning the lumen output of lanterns, the lumens per 100 ft. run of the roadway mounting height and spacing, the distribution of the light along the roadway might be specified as in Table No. 1 (assuming a mounting height of 25 ft.). By the adoption of suitable limits for the ratio Ix/Ii, satis-

Table I.

Point No.	Distance from Foot of Post No. 1.	*Ix/Ii	
		Max.	Min.
1	—	1	1
2	36 ft.	.5	.2
3	77 ft.	.2	.06
4	113 ft.	.075	.025
5	190 ft.	.015	.005

* Ii = Illumination at Point 1.
Ix = Illumination at Points 2, 3, 4 and 5.

factory brightness would be ensured and at the same time excessive glare would be avoided.

It may be objected that such a scheme does not give any suggestion of the ideal to be aimed at. If so, then a slight modification might be adopted without any deviation from the fundamental principle of measurement on the road surface. The specification could take the form of target figures at each of the points of measurement with permissible variations on each side of that target figure as in Table II.

Such a scheme would suit non-cut-off type installations, but cut-off installations would naturally show no measurable light at 82½ deg. from the downward vertical. If, however, the earlier suggestion of dividing the distance between adjacent posts into four equal steps were adopted, then

Table II.

Distance from No. 1 Post Position		Ix/Ii	Permissible Variation
1	—	1	—
2	36 ft.	.40	± 33%
3	77 ft.	.13	
4	113 ft.	.055	± 50%
5	190 ft.	.010	

the method could be applied equally to cut-off and non-cut-off installations and would ensure reasonably good road surface brightness by bringing the light from one lamp right up to, and in ordinary circumstances beyond, the foot of the next column.

I would like to emphasise that these examples I have given are only illustrations of how we might draw a specification that would perhaps help to implement our modern ideas regarding good street lighting. Whether they—the illustrations—meet with your approval or not is beside the point; they should not be regarded as an essential part of the argument for drawing up a specification based on measurements taken on the road itself.

To conclude, I would like to go back to where I started and ask—What is it we wish to specify? If it is street lighting, then let the specification deal with the lighting of the street and on the street.

I.E.S. Fellowship

The following application for Fellowship has been accepted:—

Charity, Jonathan B.

Erratum

Attention is drawn to the following error which occurred in the issue of "The Transactions" for January, 1944, page 19 ("The Sky Factor Value of Windows," by P. J. Waldram, F.S.I.):

For "6 ft. 6 ins." in fifth line from bottom of second column read "6 ins."

With a view to avoiding possible confusion with other publications, reference to these Transactions should be in the form :—"Trans. Illum. Eng. Soc. (London)."

The Illuminating Engineering Society is not, as a body, responsible for the opinions expressed by individual authors or speakers.

STREET LIGHTING SPECIFICATION—CODE OF PRACTICE AND CORRELATED STREET LANTERN SPECIFICATION

By R. MAXTED, B.E.(Electr.), B.E.(Mechl.), M.I.E.E., F.Inst.P. *(Fellow)*

(Introduction to a Discussion which took place on December 14, 1943).

This contribution advocates, for any adopted system of street lighting, a Lantern Specification and a correlated "Code of Practice," the latter containing guidance on the appropriate principles of installation design. Support for the proposal is based on the following considerations:—

I. A specification based directly on visibility is a prospect too distant to be of practical interest.

II. Skill in the design of street lighting is such that a successful result can be predetermined and could be ensured by the *competent* interpretation of functional Codes and Specifications.

III. The basic knowledge available is adequate for the framing of functional Codes and Specifications of a generally fundamental character, leaving scope for the encouragement of skilful design and of further development.

IV. A well-conceived Lantern Specification has inherent advantages upon which would depend the necessary flexibility of the Code of Practice.

In what follows these points are reviewed, and it is stressed that the validity of the proposal depends on the opportunity to frame Codes for interpretation by competent lighting engineers.

A comprehensive scheme of Codes and Specifications is envisaged, the whole co-ordinated by a General Code giving guidance on broader technical policy. A series of "associated" Codes is also suggested for the co-ordination of other matters technically allied to street-lighting.

"Visibility" Specification—a Remote Prospect

Efforts to specify an ultimate result are defeated by the indefinable nature of visibility. It is, however, common experience that fundamental analyses remain baffling long after the establishment of successful practices. This is true of street lighting, where reliable techniques have been evolved well in advance of a definition of visibility, and even in the absence of a surviving "figure of merit." Continuing development can be expected to produce an ever-increasing understanding of basic requirements, and a corresponding improvement in practical effectiveness. But progress, whether evolutionary or revolutionary, is more likely to confirm "visibility" as a complex function controllable by a combination of science and art, than to reveal a simple commodity definable in a few words and specifiable by numbers.

Hence it is tolerably certain that a performance specification based on visibility is, at best, a very distant prospect. It does not necessarily follow that the restrictions of an entirely arbitrary specification need be endured. It should not be beyond the wit of those mainly responsible for a successful technical development to devise functional Codes and Specifications which would consolidate and extend the use of present-day good practice, whilst avoiding stagnation and encouraging skill and further development. With this thought can be coupled the fact that the most backward industries are those which have resisted standardisation. One is led to the conclusion that it would be wise to press on with functional Codes and Specifications based in general on those theoretical factors most closely identified with a successful practice.

Functional Codes and Specifications

It is the aim of functional Codes and Specifications to ensure the use of *methods and means* which have proved successful in producing visibility. The part of the Lantern Specification is to secure the supply of equipment fulfilling certain essential functions, of consistent performance, and devoid of proven defects. The

Code of Practice should preserve the essentials of a successful technique in applying the specified lantern functions.

The danger of a functional Code or Specification lies in a too arbitrary treatment which would frustrate skilful design, and inhibit future development. This may be avoided if two conditions can be met. The first is that the drafting of Code and Specification can be guided by a clear appreciation of the principles underlying successful practice and current developmental trend. The second is that the Code can be framed for interpretation by engineers whose skill justifies scope for the exercise of judgment.

Specifications based primarily on the level of illumination provided, or on the brightness distribution produced, are not "functional"; they are perhaps pseudo-fundamendal, the unjustified assumption being that the illumination or the brightness is an over-riding factor, identifiable with visibility. It is the essence of the functional scheme that guidance is given on methods of repeating previous practical successes. This is apparently the only feasible approach in street lighting, especially so long as the ultimate result is also dependent on factors beyond the control of the lighting specialist—that is, road design, and choice of road surfaces.

Successful Street Lighting is Predictable

The crucial question is whether the development of basic theory, and of the ability to predetermine a successful design, is such as to promise success in the use of functional Codes and Specifications.

It is suggested that at least one system has been developed to a stage where both the National economy and technical progress could and should be well served by enlightened Codes and Specifications. Successful Traffic Route Lighting has been evolved, and trial and error methods have been displaced by a rational design procedure. This trend was greatly accelerated in the period 1933-39 as significant factors were noted under practical conditions, and investigated under the general guidance of those engaged on more fundamental research.

It was relatively easy to meet pedestrian needs, but for the greater safety of all road users it was necessary to give the faster moving motorist a quicker and clearer perception of distant street features and objects. The technical and economic potentialities of silhouette vision were recognised and exploited. The mechanism of road reflectivity, and the significance of lantern siting and of lantern characteristics were studied, and correlated techniques were evolved. Methods were modified to enhance significant brightness contrasts, as at the kerb line, and to ensure the silhouetting of objects. The need for additional bright vertical backgrounds was realised. The implications of "subjective" brightness were considered, and it was confirmed that a reduction of lantern intensities at critical angles gave an effective increase of the observed background brightnesses, due to the reduction in accumulated glare. The acceptance of this last principle was reluctant, perhaps due to a natural distrust of "something for nothing."

In this way the principal factors in successful design have been recognised, as can be demonstrated in practice. Thus it is known that when a suitable (standardised) lantern distribution is associated with an adequate luminous output in a competently planned installation, good visibility is obtained under widely differing street conditions—given suitable but practical road surfaces and other backgrounds.

Confidence in this respect is due mainly to the development of workable theory, acceptable on fundamental grounds, and proven in practical experience. It may therefore be claimed that the "silhouette" system of Traffic Route Lighting could fulfil the requirements stated above for successful functional Codes and Specifications. Nor is the claim to technical prowess in conflict with the admitted inability to define visibility. As in many other branches of engineering, an advanced state of development has

been reached by practical experiment, intelligent deduction, and the formulation of interim but profitable theory. Even where fundamental knowledge is most meagre, the theoretical sifting of practical experience often produces marked technical and economic advances.

Specifications for the Layman and the Professional Engineer

Some would state as a first condition that a street-lighting Specification should be such that the layman can check compliance. This may seem a reasonable proposal, since layman and expert alike are more or less equally equipped to see—at least physiologically. Furthermore, not many years have elapsed since there was little to choose between the judgment of expert and amateur. There is, however, no point in concealing the fact that a relatively short period of intensive scientific development has radically changed the position in street lighting as in many other subjects, notably radio. Any attempt to frame a layman's specification would probably result in an over-simplified and yet an unduly rigid approach to the subject which would deny the competent engineer sufficient scope. The overall result would almost certainly be a mediocre practice and an almost complete inhibiting of further development.

The layman and the lighting engineer have a common interest in the adoption of Codes and Specifications which, as administrative devices, provide common ground for the negotiation of the required services. The layman's technical responsibility in regard to public services is primarily to satisfy himself that the administration is in competent hands, and that a nationally accepted standard of practice is adopted. He is able to judge whether the service is in general satisfactory, but beyond this he relies upon the ability and integrity of experts.

In street lighting, it must be the trained engineer's responsibility to provide against subtle defects and dangers, such as the inversion or lack of vital contrasts. Codes and Specifications should clearly be designed primarily to aid the skilled and experienced engineer, and to encourage engineers to adopt Street Lighting as a professional occupation.

The Advantages of a Street Lantern Specification

The virtues of a Lantern Specification are readily discerned in a review of the essential features of a Code of Practice. Thus, to secure each function of the lantern siting, it is necessary to impose corresponding photometric requirements upon the lantern. The really vital requirements can all be stated as intensities required in directions relative to the lantern position. Furthermore, the intensities in one general direction are required to bear a certain relationship to intensities in other directions, and the sum total provides the salient boundaries of a lantern distribution.

It is possible to gain several advantages by relieving the Code of piecemeal photometric requirements, which can then be assembled as a coherent "Lantern Performance" Specification. I would suggest that this procedure is *necessary* to an effective appreciation and control of the various functions involved in the provision of street lighting—the investigation of lantern design, of road surface characteristics, and of installation design; the planning of installations, the diagnosis of defects, and the checking of overall maintenance; and the ordering, testing, and maintenance of lighting equipment.

In installation planning, the street lantern may be regarded as the basic unit of a tactical formation in which, if a predictable result is to be achieved, each unit must play a predetermined and well defined part. Indeed, it is difficult to visualise reliable planning without the guidance provided by a clear conception of the salient characteristics, and the sphere of operation of the individual unit. In my view, therefore, a lantern specification is the natural product of that appreciation of underlying principles, which alone can counteract any unavoidable looseness or arbitrariness in a Code of Practice. Most installation designers will, I imagine, agree that some such idea has lead them to

frame informal lantern specifications for their own guidance in the past.

Finally, to ordering and testing. The opening gambit of a Code may well be, in Mrs. Beeton's phraseology, "take a thousand suitable lanterns." Mrs. Beeton had a clear idea of the characteristics required of a hare, and her reputation would no doubt ensure the supply of appropriate specimens. In an earlier discussion of street lighting,[1] however, Mr. Percy Good has pointed out that "... when attempting to make a specification which would deal with buying and selling a commodity, it would be a great deal better if conformity with that specification could be measured in a test room or laboratory."

Thus the necessary rigidity may be imparted to the Lantern Specification, while retaining the greater flexibility desired in the Code of Practice.

Lantern Functions in Traffic Route Lighting

A scheme of Codes and Specifications must contemplate various methods of lighting, but the "Silhouette" system has been intensively developed for Traffic Route Lighting and is well suited to an analysis of the general problem of Lantern Specification.

It is well appreciated that each lantern produces, on the road surface, a bright area lying between the lantern and the observer. A Code of Practice should give guidance on the placing of lanterns, and of the resultant bright areas, so that these present a continuous bright surface to the road traveller. One purpose of a Lantern Specification is to ensure that the lantern can fulfil the functions necessary for the production, in any required direction, of an area of adequate brightness and extent. The equally important counterpart is to ensure that the lantern characteristics do not depress eye sensitivity and thereby reduce the apparent extent and brightness of the area.

Road reflectivity and the siting of lanterns have been considered in detail elsewhere ([2, 3]), and this review of lantern functions is to some extent a summary of earlier analyses ([1, 4]). The present purpose is to note items for a Lantern Specification.

Mounting Height, Spacing and Cut-off

With lanterns mounted at 25 ft. and spaced at 300 ft. in a single straight row, light must be projected along the road up to an angle of 86 deg. It may be stated as a general requirement that the lantern cut-off should not occur below an angle given by the simple formula:—

Minimum Cut-off Angle

$$= \tan^{-1} \frac{kS}{H}$$

Where

H = mounting height
S = spacing per row
k = 1.25 (approx.)

Background Brightness, Glare and Cut-off

To achieve an adequate bright area, the lantern intensity must be increased progressively from 0 deg. to about 80 deg., and it is generally accepted that the maximum intensity may be up to six times that at 0 deg. High intensities at and near the horizontal are, however, the cause of disability glare which depresses the apparent or subjective ([4, 5]) brightness of backgrounds. Thus theeye is directly illuminated by every lantern, the more distant being on the normal line of sight. Areas of lower brightness on the road surface, and especially on wet surfaces or outlying backgrounds, are rendered "dark" by this effect.

It is not difficult to demonstrate that a marked extension of visible areas is achieved by a progressive reduction of lantern intensity from 80 deg. to 90 deg., and this applies equally to light sources of low intrinsic brilliancy. The effect of glare is readily checked in any installation by alternately shading and exposing the eyes to the light sources while observing the backgrounds—a sheet of cardboard held at arm's length is adequate.

If subjective values are low, shading of the eyes will appreciably extend and brighten the visible areas.

Where an effective compromise has been adopted the change is small.

The case for the projection of light between 86 deg. and 90 deg. rests primarily on the need for longer bright areas from each lantern on a gradual road curve, or on wet road surfaces. The road reflectivity shows a sharp upward trend at angles of incidence exceeding 80 deg., and relatively low lantern intensities are sufficient—indeed *necessary* to help limit the glaring reflections from a wet road. Further support for the retention of a low intensity up to the horizontal is provided by the desirability of maintaining a favourable and reasonably steady state of eye adaptation. For the faster moving motorist both glare and eye adaptation have pronounced kinematical aspects, and it is important to avoid disabling or disconcerting effects, such as, for example, the repetitive glare typical of too sudden a cut-off at 70 deg. or 80 deg.

All these factors point to a progressive reduction of intensity from a maximum at about 80 deg. to an appreciably lower value at 90 deg. A reduction to 25 per cent. of maximum has given very satisfactory results under widely varying practical conditions, and this value might with advantage be adopted pending a more precise determination.

Vertical Polar Curve for Principal Arcs of Azimuth

If the foregoing assessment of lantern functions is acceptable, there would seem to be sufficient data available for a statement of the main boundaries of the vertical polar curve to be provided over principal arcs of azimuth. The following are suggested for inclusion:—

Maximum Intensity

(a) To be at an angle above 75 deg. but below 82.5 deg.

(b) To be not less than three times, nor more than six times, the mean value in the cone 0 deg.—30 deg.

Cut-off

(a) Not to be complete below an angle $= \tan -\frac{1.255}{H}$

(b) Intensity at 90 deg. not to exceed 25 per cent. of the maximum intensity.

Principal Arcs of Azimuth

The width of the bright lane produced by a single lantern is determined by the characteristics of both lantern and road surface. While the road surface may exert an overriding control, it is clear that an adequate brightness can be expected only from areas served with appropriate intensities. The principal polar curve should therefore be maintained over a suitable angle in azimuth.

The extent of this angle, or azimuthal arc, is determined principally by consideration of the range of directions from which a lantern may be approached, and in which an optimum bright area is required. Quite normal road conditions call for the maintenance of the principal polar curve over two arcs, each from 10 deg. on one side of the lantern axis to 25 deg. on the other. For lanterns sited at T junctions the principal azimuthal arc may be required to extend for 200 deg. and at roundabouts for 200 deg. to 360 deg.

Clearly, a lantern specification should classify photometric distributions in accordance with the number, extent and location of the azimuthal arcs over which the principal polar curve is to be maintained.

Illumination of Additional Backgrounds

In addition to the primary function of producing road-surface brightness, the lantern has also to provide suitable illumination of background surfaces coming within its more immediate sphere of influence beyond the road surface. These are frequently vertical surfaces, either existing or to be provided at crucial points as recommended in the "Code of Practice." This function is often by no means secondary in importance to the production of road-surface brightness, and the Lantern Specification should state a requirement for directions separating the "principal arcs" of azimuth. The shape of a suitable polar curve, while not determined by

a concourse of factors, should perhaps effect a reasonable compromise between the illumination of useful backgrounds and of upstairs windows in built-up areas.

Photometric Contents of a Lantern Specification

The specification should provide a means of negotiating the supply of equipment to fulfil agreed functions. Forms of light distribution can be classified broadly in accordance with the types of lighting systems and the corresponding lantern functions required. It is suggested that, for each such system, there should be a separate Lantern Specification and allied Code of Practice.

Forms of Light Distribution

For any one system of lighting—e.g., Group "A" Traffic Routes as visualised in the M.O.T. Report—alternative Principal Polar Curves may be considered desirable to accommodate justifiable variations in technique. It is suggested that the Specification should include such alternatives, guidance on choice being given in the associated Code of Practice. The classification of Polar Curve shapes should be on the principle of salient boundaries rather than of precise distributions.

Lantern distributions should also be classified in regard to the number, extent, and location of arcs of azimuth over which a particular polar curve is to be maintined, as for lanterns sited normally, at T junctions, or at roundabouts.

Classification on these various bases should be on the principle, not of covering every conceivable form of distribution, but of the inclusion of such variations as have been shown in practice to warrant serious consideration.

Total Luminous Output

Having classified the *shapes* of lantern distributions, the Specification should next provide a classification on the basis of the total luminous output *of the lantern.*

Principal Photometric Classifications

To summarise, it is suggested that the Lantern Specification for any one system should classify adopted lantern distributions under the following headings:—

(a) Salient Boundaries of Principal Polar Curves.

(b) Number, Extent, and Location of Principal Arcs of Azimuth over which any Polar Curve should be Maintained.

(c) Total Luminous Output of Lantern in Standard Condition.

Lantern Performance under Standardised Conditions

An agreed basis should be provided for the measurement and expression of lantern performance under *standardised conditions.* This would refer to measurements in the Test Room or Laboratory, and would concern the determination and representation of lantern characteristics. Both the detailed form of light distribution and the total luminous output should be included.

Brightness of Source or Unit

This may be a significant factor in some classes of side-street lighting where a low mounting height precludes the use of effective directional equipment.

For Traffic Route Lighting, however, it can be shown that the control of cut-off exerts an overriding influence on glare, even at source brightness as low as 10 candles per square cm. It is therefore important that any clause on source brightness should not prejudice lantern design as regards the effective control of lantern distribution.

Maintenance of Performance in Service

A statement should be given of the minimum percentage of standard performance to which the total luminous output may be permitted to fall in service. For various types of lantern and of local atmospheres, this figure will determine the permissible servicing intervals.

Methods of determining the rate of depreciation in a local atmosphere should be given. This might be based on test room measurements of the clean, and later the depreciated, performance of lantern and lamp, the

two factors being separated out for effective control.

An overall field check of lantern, lamp, and supply could be based on measurements at the road surface, using a directional foot-candle meter. These measurements could then be compared with the corresponding standard values plotted on an Iso-foot-candle diagram. There is no point in converting to horizontal illumination for this purpose, and the full incident value has greater significance.

A maintenance clause should also place limits on change of shape of the distribution of a lantern while in service. Test room measurements are greatly to be preferred for the checking of performance in this respect, since convenient and accurate field measurements are not applicable to intensities near the lantern horizontal.

Codes of Practice—Installation Design

It is suggested that a Code of Practice should be confined to a particular system of lighting and be closely associated with the corresponding Lantern Specification. The Code should explain the accepted principles of the system, and give guidance on installation planning, on the selection of lantern distributions appropriate to various siting practices, on the choice of total luminous output of lantern, and on installation maintenance limits.

Thus, for the system contemplated in the M.O.T. Report for Traffic Routes, Group "A," the Code should describe the principles of the "silhouette" method; and guidance on siting would include much of the appropriate material contained in the Report. The Code should also give guidance regarding the provision of additional vertical backgrounds.

Codes of Practice—Road Surfaces and Other Backgrounds.

It is notorious that unsuitable road surfaces will defeat the most ingenious street-lighting techniques. It is generally accepted that little can be done by the lantern designer, who is in fact urged, in the M.O.T. Report, to avoid waste of effort in this direction. In general, it is the more economical "silhouette" system that is affected, and the only obvious course is to reduce glare and greatly increase the road illumination, probably by the use of close-spaced low cut-off units of high power.

While this state of affairs is occasionally placed on record, and even brought to the attention of road designers, there would appear to be no sustained effort directed towards the liberation of the lighting engineer from this incubus. Such action might aim at two objectives. That of limited, though more immediate value, would consist in giving guidance upon the special siting of lanterns and on the use of additional backgrounds—e.g., beyond smooth, wet surfaces. This is, however, making the best of a counsel of despair, and the major though longer term effort should be towards influencing the choice of road surfaces. Pressure in this direction is unlikely to be fruitful unless accompanied by coherent evidence, and a clear indication of the street lighting requirement.

A Code of Backgrounds should of course give detailed guidance on the technical and, perhaps, the administrative problems of providing addition vertical backgrounds. There is already much valuable but scattered experience which could be collected and presented in an authoritative form.

With both courses in view ,I would suggest the appointment of a committee whose function would be to gather together, classify, and make generally available in a Code, data on the influence of backgrounds in general, and of road surfaces and road design in particular. In the aggregate, there is probably a great deal of knowledge already, and I would offer one example. This is the observation that rough, non-flooding road surfaces show the least variation in result as between dry and wet conditions. The wet surface maintains a broad bright area, devoid of distressingly glaring streaks, presumably due to the suitable scattering of light by the innumerable specular facets. Thus there are two basic advantages—first the restriction of disabling glare from the road surface, and the resultant maintenance of eye sensitivity so that lower background brightnesses are visible; second, the maintenance of

the lower road surface brightnesses at a sufficient level. Such data could be presented in the form of standard photographs showing the results obtained with specified lantern distributions on classified road surfaces.

The M.O.T. Report expresses the obviously correct view that "the selection of road surfacing materials must be governed by considerations of economy, and the production of durable non-skid surfaces." If, however, the importance of street lighting to the National Economy is such as to warrant a three-year investigation by a Departmental Committee, it is reasonable to suggest that the development of suitable road surfaces is a prime "consideration of economy." Having regard to the resources of civil engineering, it may be assumed that this is primarily a matter of the provision of convincing proof of the need, and the indication of a clear and unambiguous requirement.

As regards the influence of road design, therefore, a Code might have the following functions:—

(a) To provide a general basis of collaboration between road designers and lighting engineers.

(b) To demonstrate that the success or failure of competent street lighting practice depends more on road design than on any other factor.

(c) To indicate types of surface having appropriate reflection characteristics, and other features in road design which aid visibility.

(d) To provide a means of classifying surfaces in accordance with reflection characteristics.

(e) To give guidance, of limited value, to street lighting engineers under the present adverse circumstances—in this, being more in the nature of a warning to less experienced installation designers.

The attainment of standardised road design might lead to street lighting specifications based on brightness distributions.

General Scheme of Codes and Specifications.

Advocacy of the adoption of Lantern Specifications and correlated Codes of Practice—each pair applicable to a particular system of lighting—naturally implies the provision of a General Code designed to co-ordinate Street Lighting Practice as a whole. This General Code should outline a comprehensive scheme into which would fit all the Codes and Specifications likely to be required.

Such a scheme would be more flexible than an omnibus Specification, and would greatly facilitate the very necessary business of keeping individual Codes and Specifications abreast of new development. Thus provision would be made, not only for increased efficiency in design practice, but also for the convenient and swift drafting of new Codes, and revision of existing Codes.

The General Code would be a convenient vehicle for statements of broad policy, and while many potential functions would become apparent only at the drafting stage, some may be hazarded now:—

I. Statement of broad policy — Technical, Economic, or Administrative.

II. Outline of comprehensive scheme of co-ordinated Codes and Specifications.

III. Classification of streets and highways.

IV. Guidance on the system of lighting best suited to given circumstance (e.g. where the 150 ft. spaced "silhouette" system may be recommended for routes carrying fast through traffic, a close-spaced, low cut-off, higher powered system might be preferred for denser traffic).

V. Guidance on the appropriate linking-up of street lighting of different categories or systems.

VI. Guidance on Amenity—Good appearance of Installation and Equipment. Avoidance of discomfort glare where possible.

VII. Guidance on the use of a new or modified system not yet the

subject of a Code or Specification. Provision for developmental trials on an adequate scale. (e.g., to check if one-way vision is acceptable on dual carriage ways.)

One function of individual Codes of Practice would be to co-ordinate the results of practical experience and of scientific research and development. They should also provide both the installation designer and the equipment designer with an authoritative account of the basic relationship between specified equipment and installation design practice.

Two series of Codes may be contemplated, the first group referring to street-lighting systems proper, and the second to subjects associated with street lighting, or influencing it so intimately as to require a co-ordination of practice.

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The Street Lighting Series might, for example, include:—

I. Traffic routes, Group "A"—150 ft. spaced "Silhouette" system.

II. Traffic routes, Group "A"—70 ft. spaced, low cut-off system.

III. Traffic routes, Group "A"—Unidirectional system.

IV. Traffic routes, Group "B"—System "X."

V. Side streets—System "M."

The "associated" series of Codes may include:—

I. Code of Street Lighting Practice—Road surfaces and other backgrounds.

II. Code of Street Lighting Practice—Street signs.

III. Code of Street Lighting Practice—Brightness and location of advertising signs.

IV. Code of Street Lighting Practice—Vehicle lights in city areas.

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(2) Road Surface Reflection Characteristics and their Influence on Street Lighting Practice. J. M. Waldram. Illuminating Engineer, October, 1934.

(3) Ministry of Transport, Departmental Committee on Street Lighting. Final Report, August, 1937.

(4) Street Lantern Characteristics. R. Maxted. Electrical Review, May 13th and 20th, 1938.

(5) The Response of the Eye to Light in Relation to the Measurement of Subjective Brightness and Contrast by W. D. Wright. Trans. Illum. Eng. Soc. (Lond.) Vol. IV, No. 1, January, 1939.

(6) Ministry of Works, Codes of Practice Committee, First Report, 1943.

DISCUSSION

The PRESIDENT (Dr. H. Buckley), in opening the proceedings, said that the Society and the Association of Public Lighting Engineers had a great deal in common in connection with street lighting. He welcomed the President of the Association—Mr. E. J. Stewart—its secretary, Mr. Davies, and its members to this joint meeting. He imagined that one of the first things which would be done after the war was to restore street lighting. A great deal was being said as to post-war planning and it was to be hoped that this would lead to a consideration of the very valuable Ministry of Transport Report on Street Lighting which appeared before the war. Street lighting authorities and others concerned would be very much interested in implementing that Report. One of the things the Report called for was the preparation of a detailed specification for street lighting. This immediately raised the question as to what the basis of such a specification should be. Should it be based on the illumination to be provided in the street or on the design of the fittings which were supposed to produce that illumination? Dr. English and Mr. Maxted would put forward opposite views on this matter in order to start a discussion. However, it was not the purpose of the meeting to pass any resolution or to come to any conclusion as regards what this specification should be

based upon. Therefore, those who took part in the discussion were quite free to say what they liked and that they would not be held to task and embarrassed by reference to what they said now if they changed their views in the future.

Mr. E. J. STEWART (President, Association of Public Lighting Engineers), after expressing appreciation of the opportunity given to his Association to take part in this discussion, said that perhaps Dr. English and Mr. Maxted were not so entirely opposed to one another as might at first appear. It was quite clear there must be a test in the street, however rough, in order to check what was specified in the laboratory. It was also necessary to test in the streets to see if a lighting scheme had been carried out according to contract, if there was one, and it was really important to see if the installation was effective in the view of the users. Therefore, some criterion of visual efficiency was necessary and a street lighting visibility meter was wanted. Much thought had been devoted to measuring and recording visibility, but it had been found much more difficult to specify it. In any case, whatever was measured, there must be a test on the street. A great deal depended on the proper spacing of the lamps at the most suitable heights, and no specification could do this because of the varying conditions that must be encountered in different streets in different towns and cities. Visibility must be kept in mind all the time. Absolute visibility could not be expected at all points under all conditions, and there was more than one problem involved. A check was necessary to see if the lanterns ordered really gave the results anticipated after delivery, and that could be done in the laboratory by finding the candle-power distribution; but it was also necessary to ensure that the lanterns were placed in the street in the proper position. It had happened that a lantern could be put the wrong way round. There must also be periodical tests to ensure that there was proper maintenance. Visibility introduced many variable factors which differed from time to time and from place to place. He suggested that public lighting engineers should endeavour to ascertain for themselves the local conditions and their effects before setting the problem of lantern design to and worrying contractors or whoever was to be responsible for the installation. In this way the laboratory work could be carried out in conjunction with practical tests in the street.

Mr. T. WILKIE said he thought there was no alternative but to design lantern characteristics. Hardly one of the many factors influencing a lighting installation was under the control of the lighting engineer, and in saying this he was thinking of what had happened in the past. At present, when designing an installation, the lighting engineer thought of height, spacing, etc., but even the actual spacing was not always under his control, and it was not until after the lantern had been designed that the installation was planned. It was necessary to think of the fundamentals, and lanterns must be designed to accord to these fundamental conditions. He did not know of any manufacturer of lanterns who, being asked to submit a tender, asked if he could examine the street at night, and although Mr. Stewart had said there must be a test in the street, personally he preferred to do his testing in the laboratory—in comfort and safety! Whilst he bowed to no man in his admiration of the work done by certain manufacturers in their laboratories, was it not possible that street lighting was being made a little too complex? Lighting engineers were practical men and had to look at the matter from that point of view. There should be a lantern specification which would indicate that, within certain limits, lanterns labelled A, B, etc., were suitable for certain streets, and that would facilitate the holding of stocks of lanterns by the public lighting department.

Finally, Mr. Wilkie said he would give his vote unreservedly for Mr. Maxted, because lantern characteristics was the method that should be adopted. We did not test the filaments of lamps in drawing-rooms; they were tested in the laboratory.

Mr. J. M. WALDRAM said he had served for some years on the B.S.I. Committee, which had been trying to draft a specification for street lighting, and he was one of the many people who had had to thresh out the details. As a result, he supported Mr. Maxted. For fifteen years the endeavour had been made to produce a specification for street lighting; but although as a result street lighting had benefited from the attention given to it, it had not been possible to produce a specification which was really satisfactory. This fact was evidence in itself. It had been said that "questions which produce meaningless answers usually turn out to have been meaningless questions." In asking for a specification for street lighting, were they not asking a meaningless question? Other B.S.I. specifications were almost invariably for articles and materials. There were, for

example, specifications for materials and parts of a house; but there was no specification for a house—that was a matter for the architect. It was only possible to specify by reference to particular properties, and then only when they were definable, measurable, and under control. In his view, all that could be done in any specification was to specify sound materials, and to use them on sound engineering principles to make an acceptable compromise between conflicting requirements. The specification should be for the materials; the principles could be stated as a code of practice, but unfortunately we could not have a British Standard Compromise. Many of the things we most desired in this life were quite unspecifiable. Dr. English had said there should be a specification for good visibility—or words to that effect—and alleged that if we could not do that we were ignorant of our subject. In fact, our knowledge of the subject had shown us what it was possible to specify and what it was not. We now knew that there was no proper connection between illumination and visibility, and therefore one could never be properly specified by reference to the other. That had been borne out by many fruitless hours that had been spent trying to base a satisfactory specification on illumination requirements. Therefore, he hoped this matter would be dealt with in another way, viz., to specify the articles which the engineer had at his disposal, and to lay down the principles of their application in a code. If that were done, street lighting would benefit very much more than it had done under the present system.

Mr. W. J. G. DAVEY said that he preferred a specification based on illumination, as suggested by Dr. English. In this connection he mentioned a paper read by Mr. Hodkinson and himself at the Conference of the Association of Public Lighting Engineers in September last. It had then been shown that if illuminations were determined at the test points indicated on his curves, or calculated from these points from the candle-power distribution, it was possible for any experienced lighting engineer to provide for a reasonable degree of visibility.

Whilst agreeing with Dr. English that a specification should be based on illumination, he also agreed with Mr. Maxted that it could be based upon particulars of a lantern, because it was possible to determine the distribution of illumination from the candle-power distribution. The total luminous output of the lantern, however, might bear little relation to the aggregate illumination available in the street, and should therefore be excluded from the specification.

Mr. F. L. CATOR said he was in a rather different category from those gentlemen who had already spoken, inasmuch as his job was to supply Lighting Authorities with street lighting equipment and, having done so, to satisfy them that the results were according to specification. He was not inclined to agree with either Dr. English or Mr. Davey's suggestions for a specification requiring a multiplicity of test point readings. He, like Mr. Wilkie, had spent many uncomfortable hours on the streets late at night, usually in the winter, taking test point readings on his hands and knees. If only to obviate this unpleasant procedure, therefore, he was all in favour of Mr. Maxted's alternative lantern specification.

A further point was that in most areas the street lighting was in charge of the borough surveyor or, alternatively, an official of the local gas or electric supply department acting for the surveyor. Such people were not lighting engineers and could not be expected to make measurements in the streets. The result was that if illumination measurements were taken at all, they had to be taken by the manufacturers who had supplied the street lighting equipment. As an engineer employed by one such manufacturer, he would like a specification which would relieve manufacturers' lighting engineers of any possible suggestion that they might "wangle" their foot-candle readings if conditions so demanded.

He was sure, too, that Lighting Authorities would welcome as a safeguard the possibility of purchasing street lighting lanterns carrying a label guaranteeing that they conformed to an agreed A.P.L.E./I.E.S. lantern specification.

Mr. E. STROUD said that whilst there were arguments for and against what both Dr. English and Mr. Maxted had put forward, before it was possible to have a lantern specification as such, it was necessary to know what was wanted. Therefore, there must be a specification of the results required. A Street Lighting Specification was not only dependent on the lanterns but on their spacing and height on the road, and also on the width and formation of the road itself, all factors of which were inter-related to a specification of the lantern, which Mr. Cator had mentioned.

It would be very nice to have specific

lanterns which could be labelled A, B, C, etc., to cover all street lighting requirements, but having regard to the different conditions met with, it would be difficult to cover the problem by a specification for lanterns only. If the requirements were known, then lanterns could be designed to give these results under definite installation conditions. Therefore, the main requirement is a specification for the suitable lighting of a particular class of road and not of a lantern, the results of which would depend upon the conditions and their erection.

It had been mentioned that the BSS.307, specifying test point illuminations, had failed, but it must be appreciated that this test point illumination was only one factor in the whole specification. On the other hand, the B.S.S. Committee—of which he was a member—in their deliberations considered all the different factors which went to make up good visibility in the roads, and it was considered that a definite illumination at the mid-span or test point would ensure the satisfactory achievement of other salient factors. It was quite possible that in their endeavour to make the problem less abstruse they had erred on the side of simplicity In his opinion, it was absolutely essential that some means be formulated to measure the results obtained in any installation, and on further investigation it might still be found that horizontal illumination readings, whether at the mid-span or other position, were the most satisfactory.

There was the grave possibility of undue complication in this matter, and he suggested that there was a need for a fundamental specification of spacing and heights of fittings for certain classes of roads, which—together with some idea of the results required—would be possible to get a fairly simple, practicable specification which would have to be based on the results and not on the lantern as such.

Mr. J. A. PROWSE concurred in the remarks made by Mr. Cator. He, too, had spent many nights on the streets checking up against street lighting installations. It should be considered that whilst a number of comparatively large local authorities had not available a public lighting engineer, competition, not only between gas and electricity but also between various manufacturers, existed. If, therefore, a specification that could be understood by the borough engineer or the clerk to the council could be devised, this would be very helpful.

A specification, however, should go further than defining the road characteristics and the lantern design—which were complementary. It should also cover maintenance. There must be assurance not only that initial requirements were fulfilled but also that the installation was suitably maintained. There was certainly a need for a specification which would set out the fundamentals and a code of application, but the subsequent condition of the installation would depend upon the care exercised by the purchaser of it.

Mr. H. H. BALLIN expressed the view that Dr. English, instead of specifying street lighting had, in fact, put forward a rather complicated and awkward means of specifying lantern distribution. Measuring horizontal illumination on the road, as suggested by him, although useful for checking the claims of manufacturers and ensuring satisfactory maintenance, gave only a partial indication of the light distribution from one single lantern. This was no different from specifying a polar curve.

A specification of street lighting in the strict sense, if practicable, would certainly also have to take into account the effect of distant light sources in an installation and reflective properties of road surfaces.

Mr. F. C. SMITH said that in general it would probably be agreed that an ideal specification should enable the purchaser to state the requirements to the supplier, either in terms of definite physical measurement or other agreed criterion of quality or performance.

The British Standards Specification for Street Lighting, No. 307-1931, could be looked upon as an attempt to combine a code of good practice with a performance criterion. It was to be regretted, however, that the clauses in this specification which dealt with such matters as spacing, height ratio, maintenance, etc., and could, therefore, be aptly described as requirements for good practice, became subordinated to the performance clauses which were expressed in terms of an illumination requirement.

While it was accepted in the light of more modern knowledge that these clauses were not regarded by all as a sound criterion of performance, they were, however, so far as they went, of convenience to the purchaser, who was able to convey to the supplier, in terms of these clauses, the order of the lighting required for a given thoroughfare.

In practice, the surveyor learnt to associate a given order of street lighting with a given classification in the specification, and although correlation might not have been ideal, it was, in fact, a great convenience to the purchaser. It was possible, of course, as had been suggested to-night, to specify the units used in terms of a given lumen output and distribution. Clearly, if the code stops at this point one was not specifying street lighting.

A further step would be to define how these units are to be used and to give details of the required mounting height, spacing, and guidance for siting. This latter suggestion, which in its logical outcome would be a little more specific than the report of the Departmental Committee of the Ministry of Transport, clearly remained a code of practice much on the lines of the Departmental Committee report.

It was not without point that the Committee, when issuing the report, indicated that the findings would need to be implemented in terms of a specification. It had been said that to attempt to specify street lighting in terms of performance requirement was impossible, and while it was freely admitted to be difficult technically, the speaker believed it was well worth while making another attempt.

In the commercial sphere competition has been so keen that an attempt had been made to make the criterion of performance sensitive enough to differentiate between small differences in performance which in practice were of no consequence, and this fact had been responsiole in no small degree for the difficulty in drafting an acceptable specification.

Mr. A. CUNNINGTON (*communicated*): I listened with the interest of an outside observer to the very interesting discussion on the alternative suggestions for a basis on which a future street lighting specification might be provided. I came to the meeting with a predisposition in favour of specifying street lighting by measurement on the road, mainly because if this were possible it would avoid the bad fault of a too rigid specifying of height of posts, spacing, and lantern details. There has always been a danger that a standard specification may lead to the standardisation of the products of a few specialised manufacturers. If the conditions are too rigid only one or two types of fitting will meet the specification and a lighting engineer who might be disposed to launch out in a somewhat different direction is debarred from doing so. Mr. J. M. Waldram's remarks in the discussion rather lead to the conclusion that we had better not specify street lighting at all, and the comments of the public lighting engineers present seem to me also to reinforce this idea. I am inclined to think that the ideal solution rests on two main factors. Firstly to specify the necessary details (such as performance, maintenance qualities, etc.) of any type of fitting that may be applied to street lighting and then, secondly, to employ always a fully qualified lighting engineer who will know how to design a street lighting installation to suit the particular conditions arising in his area, and who will be certain to have available a standardised fitting suitable for his design. It is a matter of opinion whether under these conditions it would be necessary to have a Code of Practice dealing with the grading of street lighting.

Dr. S. ENGLISH, in reply, pointed out that the title of the discussion was whether street lighting specifications of the future should be based on the design of the unit or the effect of illumination, but Mr. Maxted had assumed that this question had already been decided in favour of lantern design and then put forward a scheme based on this assumption. He did not think Mr. Maxted had made out a case for the use of lantern characteristics, nor did he think Mr. Maxted had demolished the arguments that specifications should be based on measurements in the street. Indeed, Mr. Maxted rather condemned his own argument when he admitted he might prefer a polar curve of a certain shape and then, thinking of Mr. Waldram, he had said that Mr. Waldram might prefer a different shape. If two dozen engineers were asked the question, there might be two dozen different shapes! How would it be possible to have a specification in such circumstances. It would have to be so broad as to be quite useless.

Mr. Stewart, as a practical man, had agreed there must be tests in the streets. Whilst agreeing with Mr. Maxted that design work must be carried out in the laboratory and polar curves determined, he pointed out that that was not a specification as to what would be produced on the road. The specification was to check the performance on the road and not the design work in the laboratory. He was, however, rather astounded to hear Mr. Stewart suggest that the lumens for a particular road or a particular job might be specified without

specifying the light distribution. That —i.e., distribution of the light—however, was one of the secrets of good lighting.

He agreed with several speakers that few of the factors concerning street lighting were under the control of the lighting engineer. This being so, if lantern design alone were specified, different results would be given for different roads. It was only by specifying the measurements on the road that it would be possible to ensure satisfactory results in all cases. Some contributors to the discussion had advanced a definite argument against measurements on the roadway, and seemed to think that comfort was a deciding factor, but if they were to suggest that as the criterion to any B.S.I. Committee they would not get very much sympathy.

In view of the discussion that took place a few years ago, it was distinctly interesting to hear that Mr. Waldram now realised that street lighting was a complex problem. To that extent at least they were now in agreement. He (Dr. English) did not say, however, nor did he imply that we should have a specification for visibility. He merely said that by the proper distribution of the light along the roadway so as to produce a satisfactory road brightness without too much glare a reasonably good visibility could be produced. It should be the function of a specification to ensure this type of light distribution.

The point had been brought out as to how it was possible to specify maintenance on the road. Was the installation to be taken back to the laboratory for a test to be made, or were measurements to be made on the road without dismantling any part of the installation?

Mr. R. MAXTED, in a brief reply, referred to the suggestion by Mr. Wilkie that the whole matter was becoming too complex. This comment appealed to him because he felt that an enormous amount of experience was being accumulated and that we were probably making too many mistakes without benefiting from them. If some of the recognised variables were suitably stabilised—by the classifying of lanterns and the codifying of practice—then the influence of other factors would be more clearly observable and we should profit more quickly from experience. This procedure would simplify the problem, facilitate progress, and reduce the cost of experience.

In reply to Mr. Smith, he remarked that he could not see how a Code of Practice could in itself be a basis of contract obligation, except in the implied obligation to employ the services of a really competent lighting engineer. The Lantern Specification would provide an equitable basis for the purchase of equipment, but for reasonable expectation of a successful installation design it was necessary to rely on the skill of the capable engineer.

The Codes of Practice would prevent undesirable variation from a nationally agreed technical policy.

The Library

Dr. M. Luckiesh has kindly made the following additional presentations to the I.E.S. Library:—

SECTION No.	TITLE.	AUTHOR.	DATE.
1/57	Torch of Civilisation	Dr. M. Luckiesh	1940
1/58	Seeing—A Partnership of Lighting and Vision	Dr. M. Luckiesh and Frank K. Moss	1931
1/59	Light and Work	Dr. M. Luckiesh	1924
1/60	The Science of Seeing	Dr. M. Luckiesh and Frank K. Moss	1937
1/61	Seeing and Human Welfare ...	Dr. M. Luckiesh	1935
1/56 B	Reading as a Visual Task ...	Dr. M. Luckiesh and Frank K. Moss	1942
15/14	Color and Colors	Dr. M. Luckiesh	1938
23/26	The Book of the Sky	Dr. M. Luckiesh	1933

The following work has been presented by the Illuminating Engineering Publishing Company, Ltd.:—

11/17	Fluorescent Lighting	A. D. S. Atkinson	1944

It will be recalled that the original list of books in the Library appeared in the TRANSACTIONS for April, 1939; additions have since been recorded.

Members are reminded that the Library at 32, Victoria Street may be inspected by appointment and that copies of most books can be borrowed by post, under specified conditions.

Sessional Meeting in London

A Sessional Meeting was held in the Lecture Theatre of the Royal Institution (Albemarle-street, London, W.1.) on February 14, when the address of the president (Dr. H. Buckley), which had been inevitably deferred owing to his absence on special duties, was delivered.

The President took for his subject "Some Eighteenth-Century Contributions to Photometry and Illuminating Engineering." He referred to the early work on photometry of Bouguer, Lambert, Rumford, and others, and recalled Mr. A. P. Trotter's address on Lambert's work, delivered in 1919. The address was illustrated by lantern slides showing old prints of early photometers and forms of "illuminators," some based on methods closely resembling those in use to-day.

A vote of thanks to the President was moved by Dr. C. C. Paterson and seconded by Professor J. T. MacGregor-Morris, both of whom emphasised the pleasure and profit to be derived from the study of these early researches and expressed warm appreciation of the address.

This vote of thanks having been passed with acclamation, the President briefly responded. In doing so he expressed the Society's appreciation of the hospitality of the Royal Institution and their consciousness of the privilege of holding the meeting in its historic lecture theatre.

Additions to List of Members

The following applicants have been duly elected by the Council to membership in the Society, and their names have been added to the list of members:—

SUSTAINING MEMBER:—

City of Leeds Electricity Dept.....1, Whitehall Road, LEEDS, 1.
Representative: F. Nicholls.

CORPORATE MEMBERS:—

Baker, A. C.....c/o Ministry of Works, Engineering Division, Government Bldgs., Lawnswood, LEEDS, 6.
Bingham, B.....35, The Wicker, SHEFFIELD.
Coleman, A. S. .....140, Norton Lane, Wythall, Nr. BIRMINGHAM.
Coxon, T. .....“Allen Dale,” 6, Briery Bank, Shotley Bridge, DURHAM.
Cross, H. .....21, Longmore Road, Shirley, BIRMINGHAM.
Dalby, W. E. .....“West View,” Dixons Banks, Marton-in-Cleveland, MIDDLESBROUGH.
Dunster, B. N. .....Siemen's Electric Lamps and Supplies, Ltd., 38-39, Upper Thames Street, LONDON, E.C.4.
Griffiths, L. N. .....5, Clarence Gardens, Four Oaks, SUTTON COLDFIELD.
Hamlyn, S. W. .....Illingworth, Willowhayne Avenue, East Preston, SUSSEX.
Hardy, R. .....20, Prince Royd, Birchencliffe, HUDDERSFIELD.
Hartridge, Prof. H....Benridge, Frithwood Avenue, Northwood, MIDDLESEX.
Levy, D. .....91, Normanton Road, DERBY.
Ossitt, B. C. .....c/o The Workshire Electric Power Company, Bramhope, Nr. LEEDS.
Swabey, E. C. J. .....“The Ridge,” 414, Bradley Road, HUDDERSFIELD.
Turland, D. A. .....52, Breedon Street, Long Eaton, NOTTINGHAM.
Turner, W. .....Can End, Dalton, HUDDERSFIELD.
Ward, J. M. .....41, Etwall Road, BIRMINGHAM, 28.

STUDENT:—

Harris, J. W. .....47, Seymour Road, Southfields, LONDON, S.W.18.

TRANSFERS TO CORPORATE MEMBERS:—

Jephcott, L. C. .....3, Clifton Road, Lee-on-Solent, HANTS.
Norris, F. W. .....The Revo Electric Co., Ltd., Tipton, STAFFS.
Scargill, G. .....27, Broadgate Road, Linthorpe, MIDDLESBROUGH.

SESSION 1943-1944

Present Officers and Members of Council :—

President :—Dr. H. Buckley, F.INST.P., F.I.E.S.

Past Presidents :—

Mr. A. P. TROTTER, M.INST.C.E., F.I.E.S.
Sir JOHN HERBERT PARSONS, C.B.E., F.R.S., F.I.E.S.
Sir DUNCAN WILSON, C.V.O., C.B.E., F.I.E.S.
Dr. C. C. PATERSON, O.B.E., M.INST.C.E., M.I.E.E., F.I.E.S.
Dr. J. W. T. WALSH, M.A., M.I.E.E., F.I.E.S.
Lt.-Col. K. EDGCUMBE, T.D., M.INST.C.E., M.I.E.E., F.I.E.S.
Lt.-Com. HAYDN T. HARRISON, M.I.E.E., R.N.V.R., F.I.E.S.
Mr. C. W. SULLY.
Mr. H. HEPWORTH THOMPSON.
Mr. A. W. BEUTTELL, M.I.E.E., F.I.E.S.
Mr. A. CUNNINGTON, B.SC., M.I.E.E., F.I.E.S.
Dr. S. ENGLISH, F.I.C., F.INST.P., F.I.E.S.
Mr. PERCY GOOD, M.I.E.E., F.I.C.G., F.I.E.S.
Mr. F. C. SMITH, M.INST.GAS E., F.I.E.S.
PROFESSOR J. T. MACGREGOR-MORRIS, D.SC., M.I.E.E., F.I.E.S.
Mr. W. J. JONES, M.SC., M.I.E.E., F.I.E.S.
Mr. R. O. ACKERLEY, F.I.E.S.

Vice-Presidents :—

Mr. E. Stroud, F.I.E.S. (1942)
Dr. W. M. Hampton, F.I.E.S.
Mr. H. Weston, F.I.E.S.

Members of Council :—

Mr. H. S. ALLPRESS (1942)
Mr. J. B. CARNE (1942)
Mr. T. Catten (1941)
Mr. H. E. CHASTENEY (1943)
Mr. E. J. DRAKE (1943)
Mr. S. I. ELLIS (1942)
Mr. F. S. ETTE (1943)
Mr. W. Hetherington (1942)
Mr. J. G. HOLMES (1943)
Mr. J. W. Howell (1941)
Mr. W. C. HUSTON (1943)
Mr. H. LINGARD (1943)
Mr. F. F. MIDDLETON (1942)
Mr. E. G. PHILLIPS (1942)
Mr. W. F. Pogson (1941)
Mr. J. S. Preston (1941)
Mr. E. B. Sawyer (1941)
Mr. R. P. SAYERS (1942)
Mr. J. F. STANLEY (1943)
Mr. W. R. STEVENS (1942)
Mr. Crawford Sugg (1941)
Dr. J. W. WHITAKER (1943)
Mr. T. WILKIE (1943)
Dr. W. D. Wright (1941)

Representatives of Areas :— (ex-officio)

Midland—Mr. W. J. G. DAVEY
North Eastern—Mr. J. M. A. MITCHELL
North Midland—Mr. W. G. THOMPSON
North Western—Mr. J. A. SOMERSET
Scottish—Mr. J. DICKSON
South Wales—Mr. D. C. JAMES
Western—Mr. J. B. HARRIS

Hon. Treasurer :—
Mr. N. V. Everton (1943)

Hon. Secretary :—
Mr. J. Stewart Dow (1928)

The names in italics are those of retiring Officers or Members. The date in parentheses after each name indicates the date of election to Office or Membership of the Council.

ELECTION OF OFFICERS AND COUNCIL

SESSION 1944-1945. OFFICIAL NOTICE

IN accordance with the procedure specified in the Articles of the Society, a list of existing Officers and Members of Council, of vacancies occurring and of duly qualified persons nominated by the Council for vacancies about to occur in the offices of President, Vice-Presidents, Hon. Treasurer, Hon. Secretary, and Ordinary Members of Council, is presented below for the information of the Members of the Society.

In the event of any Members desiring to put forward other names, the Council will be pleased to receive such nominations, which should be made in accordance with the following rule (Article 48):—

> "After the issue of the Council's list, and not later than the *15th day of April* next following, any ten Members (but no more than ten) may nominate any other duly qualified person to fill any such vacancy by delivering such nominations in writing to the Hon. Secretary, together with the written consent of such person to accept office if elected, but each such nominator shall be debarred from nominating any other person for the same office at such election."

Nominated by the Council to fill Vacancies:—

***President*:—**

Mr. E. STROUD, F.I.E.S.

***Vice-Presidents*:—**

Mr. H. C. WESTON, F.I.E.S.
Mr. DEAN CHANDLER, M. INST. GAS E., F.I.E.S.
Mr. HOWARD LONG, M.I.E.E., F.I.E.S.

***Members of Council*:—**

Mr. P. V. BURNETT
Mr. W. J. G. DAVEY
Mr. W. HETHERINGTON
Mr. R. MAXTED
Mr. C. W. M. PHILLIPS
Mr. GEORGE SMITH
Mr. J. M. WALDRAM
Mr. G. T. WINCH

Representatives of Areas*:— *(ex-officio)

To be appointed by the Area Committees before October 1, 1944.

***Hon. Treasurer*:—**
Mr. N. V. EVERTON

***Hon. Secretary*:—**
Mr. J. STEWART DOW

SESSION 1943—1944

LIST OF I.E.S. REGIONAL COMMITTEES

AREAS:

MIDLAND AREA.

Chairman: W. J. G. Davey. *Secretary:* C. J. Allderidge. *Committee:* C. S. Caunt, A. Hacking, J. Martin, F. H. Pooles, A. J. Pashler, W. J. P. Watson.

NORTH MIDLAND AREA.

Chairman: W. G. Thompson. *Secretary:* R. Pye. *Asst. Secretary:* J. A. Whittaker. *Committee:* J. T. Grimshaw, A. Kelso, J. W. Howell, J. H. Mollan, E. G. R. Taylor.

(In other Areas the only existing Centre Committee serves as the Area Committee.)

CENTRES:

BATH AND BRISTOL CENTRE (WESTERN AREA).

Chairman: J. B. Harris. *Vice-Chairman:* E. J. Ireland. *Joint Secretaries:* R. E. Tucker, and D. J. Sawkins. *Hon. Treasurer:* S. M. Richman. *Committee:* R. S. Hazell, W. A. Loughton, Miss E. L. Lee, Mrs. M. B. Probst, L. C. Rettig, W. Rush.

BIRMINGHAM CENTRE (MIDLAND AREA).

Chairman: A. J. Pashler. *Vice-Chairman:* J. G. Holmes. *Hon. Secretary:* C. J. Allderidge. *Hon. Treasurer:* F. F. Middleton. *Committee:* F. L. Cator, P. Hartill, J G. Holmes, R. Hulse, H. A. Keeling, R. Mackenzie, C. F. Partridge, W. E. Prendergast, T. H. Varcoe.

CARDIFF CENTRE (SOUTH WALES AREA).

Chairman: Prof. T. David Jones. *Vice-Chairman:* T. Scott Harrison. *Past Chairman:* E. Jones. *Hon. Secretary and Treasurer:* S. G. Turner. *Committee:* T. E. Alger, R. J. Auckland, C. C. Bleach, J. S. Childs, H. W. Mabbett, J. Trevor Jones, D. C. James, W. E. James, C. E. Springsguth, J. S. Liversage, B. C. Wilkins.

GLASGOW CENTRE (SCOTTISH AREA).

Chairman: J. Dickson. *Vice-Chairman:* E. M. Hood. *Hon. Secretary and Treasurer:* M. W. Hime. *Committee:* L. Fletcher, F. Hailstones, F. M. Hale, J. M. Henshaw, J. Lawrence, D. Macfarlane Macleod, A. M. Rankin, J. H. Scott, E. J. Stewart.

LEEDS CENTRE (NORTH MIDLAND AREA).

Chairman: A. Kelso. *Vice-Chairman:* E. C. Walton. *Hon. Secretary:* R. Pye. *Hon. Asst. Secretary:* A. Grocott. *Hon. Treasurer:* H. W. Harris. *Committee:* J. G. Craven, A. E. Elson, A. E. Fowler, D. C. Henderson, T. C. Holdsworth, J. H. Jackson, A. J. Johnson, J. H. Mollan, A. Southern, A. Wilde.

MANCHESTER CENTRE (NORTH-WESTERN AREA).

Chairman: J. A. Somerset. *Vice-Chairman:* D. M. Thompson. *Hon. Secretary:* A. H. Owen. *Hon. Treasurer:* W. M. Fisher. *Committee:* W. Browning, J. Gomersall, N. C. Hodson, J. Harwood Lumsden, K. R. Mackley, J. H. Morrison, W. C. Sherry, John Walsh, H. C. White.

NEWCASTLE CENTRE (NORTH-EASTERN AREA).

Chairman: J. M. A. Mitchell. *Vice-Chairman:* E. C. Lennox. *Past Chairman:* S. I. Ellis. *Hon. Secretary:* S. D. Lay. *Hon. Treasurer:* J. Stewart. *Committee:* S. M. Cox, W. Cross, C. Fielding, J. S. McCulloch, J. N. K. Rankin, F. H. Webb.

NOTTINGHAM CENTRE (EAST MIDLAND AREA).

Chairman: A. Hacking. *Vice-Chairman:* E. G. Phillips. *Hon. Secretary:* C. S. Caunt. *Hon. Treasurer:* E. Howard. *Committee:* C. C. Barnes, A. C. Collard, J. C. Charity, G. C. Hadfield, A. E. Kidd, C. C. Small, T. E. S. Thwaite, R. Gillespie Williams. *Ex Officio:* G. D. Johnson, M. Wadeson.

SHEFFIELD CENTRE (NORTH MIDLAND AREA).

Chairman: J. T. Grimshaw. *Hon. Secretary:* J. A. Whittaker. *Hon. Asst. Secretary:* D. H. Fox. *Hon. Treasurer:* W. Berry. *Committee:* A. Blake, R. Hillier, H. B. Leighton, N. Schofield, H. E. W. Selby, E. G. R. Taylor, W. G. Thompson, F. J. E. Walker.

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